

PTO 05-3981

European Patent

Document No. EP 0 756 544 B1

**THERMOELECTRIC PRINTING UNIT FOR TRANSFERRING INK TO A**

**PRINT CARRIER**

[Thermoelektrisches Druckwerk zur Uebertragung einer Tinte  
auf einen Aufzeichnungstraeger]

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WASHINGTON, DC

June 2005

Translated by: Schreiber Translations, Inc.

Country: Europe

Document No.: EP 0 756 544 B1

Document Type: European Patent Document

Language: German

Inventor: Manfred Wiedemer

Patent Owner: Oce Printing Systems Inc.

IPC: B41J 2/005

Application Date: 11/29/94

Publication Date: 2/5/97

Foreign Language Title: Thermoelektrisches Druckwerk zur  
Uebertragung einer Tinte auf einen  
Aufzeichnungstraeger

English Title: THERMOELECTRIC PRINTING UNIT FOR  
TRANSFERRING INK TO A PRINT CARRIER

## **Description**

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The invention involves a thermoelectric printing unit to transfer ink to a print carrier. Various thermoelectric printing units are known:

During thermal printing thermal-sensitive paper is printed with a heatable printing head by heating selected spots on the paper, whereby the heated spots discolor.

During a thermal printing transfer procedure a wax layer containing color and located on a carrier foil is partially melted with the help of heatable printing elements and transferred to the paper.

In a thermal ink printing device ink is sprayed out of a jet on a print carrier. The jets manifest a heating device which can be activated individually for each jet. The ink contained in the jet is heated by the heating element, whereupon a gas bubble arises which expels the ink from the jet.

The ink is a fluid which contains color elements. In addition, it is non-toxic - for example produced on a water base - and can be heated to about 350 degrees C and causes no deposit in the jet.

The jets are usually located in a print head. The print head incorporates an ink supply from which the jets are supplied with ink by means of capillary forces. The maximum spray

frequency of such ink print devices with thermal-electric converters (bubble-jet) is limited to about 4 kHz. Depending on the size of the drops, the ink needs 250  $\mu$ s and more until the ink suctioned by capillary forces is available for the next spray process. The trigger time for the heating element in the jet is from 5 to 10  $\mu$ s, while the time for a drop formation of about 50  $\mu$ s is relatively short on the other hand. The spray frequency can in principle basically not be increased.

~~A cylindrical printing roller is known from US 4,785,311~~  
~~whose cover has a variety of passage openings for highly viscous~~  
~~ink positioned in a matrix-like manner.~~ The ink is located inside the printing roller. Each passage opening has an associated, selectively triggered heating element, with whose help a flow of the ink through the passage openings is released. The released ink flows directly due to gravity to a print carrier which is in touch contact with the corresponding surface of the print roller located in the area of the released passage opening.

The printing speed can be increased in the known printing roller. Because of the direct contact of the print roller with the print carrier which is necessary in principle there is the danger, that the passage openings become dirty and as a result the quality of the printed image is reduced. In addition,

because of the direct contact between the print roller and the print carrier it is absolutely necessary to position the passage openings on the print roller as an endless matrix. As a result the fine quality of the print resolution is limited, since the large number of passage openings must be electrically connected to a triggering device and the coupler paths are not reducible as desired. Because of the supply of ink in the print roller a change of the print color using the same print roller is extremely difficult.

This invention has the goal of providing a thermal-electric printing unit to transfer ink to a print carrier which permits a printing speed without an adverse effect on the printing resolution, the printed picture quality and the maintainability of the thermal-electric print unit.

This goal is attained by the properties of Patent Claim 1. Further refinements and variations of the invention are given in the sub-claims.

By the placement of more than one matrix line of print elements on a print drum and their filling with ink from the surface of the print drum, a high printed picture quality is achieved with a simultaneous increase of printing speed basically having any desired printing resolution. By replacement of the inking station at the circumference of the print drum the

color of the printed picture can be changed in a simple manner. The increased printing speed is attained on the basis of the multiple arrangement of the print elements. As a result the time to refill the ink in the print elements as well as the thermal stabilization can take a relatively long time. Spray frequencies of 20 kHz can be achieved. By means of a so-called overlapping triggering of two matrix lines the spray frequency can be increased to over 40 kHz. In an overlapping triggering a following spray procedure is already started, while the current spray procedure is occurring. The matrix lines of print elements positioned on the print drum with heating elements inside and the connections required for the introduction of energy can be produced with the assistance of manufacturing techniques known from semiconductor technology.

According to one variation of the invention the inking station manifests a distribution roller whose surface rolls tangentially on the surface of the print drum. The distribution roller submerges partially into a trough extending longitudinally along the roller which is filled with ink. The ink can thus be equally applied along the entire longitudinal extent of the print drum, be introduced into the print drum, and be filled into the print elements.

According to another version of the invention a striping /2 cover strip is positioned in the roller area of the distribution roller in the movement direction of the print drum that extends along the surface of the print drum and strips off any excess ink from the surface. As a result the excess ink is sent back to the inking station. The surface of the print drum is thus cleaned on any possible ink residue. The cleaning effect is reinforced by the manner of construction of the invention, whereby the cover surface of the print drum is composed of a hydrophobic and/or oligophobic protective layer. Whether the hydrophobic and/or the oligophobic protective layer is chosen, depends on the ink used.

In another variation of the invention, whereby a cleaning station is placed on the circumference of the print drum which can be made to contact the surface of the print drum, the print drum can be freed of adhering ink or dirt during longer print pauses or possibly during required cleaning intervals.

According to another version of the invention the print carrier is constructed as an intermediate carrier which rolls in the area of a counter-printing device on the printed material, whereby the printed picture is transferred to the print material. By means of the intermediate carrier a direct influence of the print material, for example paper, can be

avoided on the print drum. The reliability of the printing unit and the quality of the printed picture can be further increased as a result. The life expectancy of the print drum can likewise be increased. The intermediate carrier is preferably manufactured from an elastic material, like rubber or silicon. As a result it can adapt to a rough surface or an uneven shape of a print material, e.g., like in label printing. In a transfer print process from the print drum to an intermediate carrier an equal distance is to be maintained between their surfaces, whereby any non-sharp feature can be avoided in the print picture.

In another version of the invention a variety of print drums is associated with the intermediate carrier. The print elements of various print drums can be filled with different colors. As a result multi-color printing can be realized. Since the transfer print process at the individual print drums occurs without contact to the intermediate carrier, a color spreading can be ruled out.

Other variations of the invention are seen in other sub-claims. In the following section execution models of the invention are explained using drawings. Seen thereby are:



Figure 1: A thermoelectric printing unit to transfer ink to a print carrier with a print drum and an inking station for the print drum;

Figure 2: A print drum with an arrangement of print elements as an endless matrix;

Figure 3: A section from the surface of the print drum according to Figure 2;

Figure 4: A front side view of the print drum according to Figure 2 with a triggering unit for the print elements;

Figure 5: A cut-away depiction of a print element;

Figure 6: A print drum with an arrangement of four matrix lines running axially on the print drums;

Figure 7: A circuit diagram for triggering the heating elements of a column in the various matrix lines according to Figure 6;

Figure 8: An arrangement of individual print elements of a matrix line according to Figure 6;

Figure 9: A cut-away view of a print element according to Figure 6;

Figure 10: A print drum with a matrix line running diagonally between the front sides;

Figure 11: A cutout of the surface of the print drum according to Figure 10 with individual print elements;

Figure 12: A cut-away view of a print element according to Figure 10;

Figure 13: A thermoelectric print unit with an intermediate carrier between the print drum and the print carrier; and

Figure 14: A thermoelectric print unit with a variety of print drums associated with an intermediate carrier.

A thermoelectric print unit to transfer ink 13 to a print carrier 14 contains a circular cylindrical print drum 10 which rotates in the direction of turning 15. The print carrier 14 passes by a transfer print process point 18 in the print carrier transport device 16 at a distance 17 to the print drum. At 1/3 the transfer print process point 18 a print carrier transport device 16 and a turning device 15 of the print drum 10 are rectified. A transfer print process roller 19 is located at the transfer print process point 18. The symmetry axis of the transfer print process roller 19 runs parallel to the rotating axis of the print drum 10 and vertical to the print carrier transport device 16. The print carrier 14 is transported between the transfer print process roller 19 and the print drum 10. The print carrier 14 thereby rolls tangentially across its entire width on the transfer print process roller 19. An even distance 17 between the print carrier and the print drum 10 is guaranteed by the transfer print process roller 19.

The thermoelectric print unit also contains an inking station 11 which is positioned at the circumference of the print drum 10. The inking station 11 contains a circular cylindrical distribution roller 12, whose surface rolls tangentially on the surface of the print drum 10. The distribution roller 12 is located in a trough 20, which extends longitudinally along the distribution roller 12. The trough 20 is filled with ink 13, so that the distribution roller 12 is partially submerged, for example for about half of its circumference, into the ink 13. During submersion the distribution roller 12 accepts ink 13 and transfers the ink 13 adhering to it to the print drum 10. In order to be able to transport sufficient quantities of ink 13, the distribution roller 12 contains porous material.

A striping cover strip 21, which extends along the surface of the print drum 10, is placed in the turning direction 15 in the rolling area between the print drum 10 and the distribution roller 12 and removes excess ink 13 from the surface. The excess ink 13 is caught by the trough 20 and then sent by a means that is not shown to the ink supply 13 located in the trough 20.

The thermoelectric printing unit also contains a cleaning station constructed as a cleaning roller 22. The cleaning roller 22 can be so swiveled on the print drum 10, that it rolls across the entire width of the print drum 10 and tangentially on it.

The surface of the cleaning roller 22 is constructed of an absorbent material, for example a blotter. In the event the cleaning roller 22 is swiveled to the print drum 10, the inking station 11 or its distribution roller 12 is swung away from the print drum 10.

Located on the print drum 10 are matrix lines 33 stretching from one front side of the print drum 10 to the other front side. ~~A matrix line 33 is composed of a variety of individual printing elements 30.~~ The printing elements 30 are constructed as recesses in the surface of the print drum 10, whereby a selectively activated heating element 31 is located in the recess.

According to Figures 2 and 3 a variety of matrix lines 33 runs axially at an equal distance on the print drum 10. ~~The line separations 34 also correspond, as do the column separations 35, to the resolution of the print picture.~~ The placement of the print elements 30 thus corresponds to an endless matrix. With a resolution of 240 dpi (dots per inch) corresponding to a line separation 34 and a column separation 35 of  $1/240^{\text{th}}$  of a line. ~~The diameter of a recess of a print element 30 amounts to about 50  $\mu\text{m}$ .~~ The heating elements 31 contained in the recesses of the print elements 30 are selectively activated by a network of

~~column and line connections 42, 43. The column and line leads 42, 43 are coupled to a triggering unit 40.~~

According to Figure 4 the triggering unit 40 is placed on the front side of the print drum 10. The triggering unit 40 is constructed as a module which manifests a variety of integrated circuits and is mounted on the front side of the print drum 10. By means of bonding or laser beam welding the connections are made to the column and line leads 42, 43. The placement of the triggering unit 40 on the print drum 10 ensures, that these matrix lines 33 are provided with print information furnished by the printing and copying unit which is located at the transfer print process point 18.

The print element 30 is constructed as per Figure 5. An initial coating 24 is applied to the carrier 23 which forms the core of the print drum 10. Column leads 42 are embedded in this layer 24. In a second layer 25 located over the first layer 24 line leads 43 are embedded. At the intersection points heating elements 31 are emplaced between the column leads 42 and the line leads 43. The second layer 25 manifests circular cylindrical pass-throughs at the intersection points which form recesses extending up to the heating elements 31. A protective layer 26 is provided on the heating element 31 in the area of the recess that prevents a direct contact between the heating

element 31 and the ink 13. A third layer 27 which encloses the second layer 25 forms the covering surface of the print drum 10. The third layer 27 manifests funnel-shaped pass-throughs 36 aligned with the recesses of the print elements 30. The third layer consists of a hydrophobic material. An accumulation of ink 13 on the drum surface is thereby avoided. The funnel-shaped pass-through 36 facilitates the filling of the print elements 30 while avoiding inclusion of air by means of the distribution roller 12.

The distribution roller 12 is always in contact with the print drum 10 during printing. The distribution roller 12 thereby supplies ink 13 to the print elements 30. The ink 13 remains in the print element 30 until the transfer print process point 18 and is removed there from the print element 30 independent of the current printing information. To do that heating elements 31 located at the intersections of the line and column leads 43, 42 are supplied with current and thus are heated. This heat is transferred to the ink 13, whereby a 1/4 steam bubble forms. The steam bubble drives the ink 13 out of the print element 30. The drop-shaped ink 13 impacts on the print carrier 14. There the ink drops deliquesce, whereby despite the non-overlapping geometric arrangement of the print elements 30 a closed written character is obtained. The print

elements 30 from which the ink 13 is removed in this manner are then filled again at the inking station 11.

According to Figures 6 to 9 four matrix lines 33, which run axially on the print drum 10 between its front sides, are placed on the print drum 10. The circumference of the print drum 10 in this version of the print drum 10 is divided into four mutually insulated sectors. Each sector beginning with the carrier 23 forming the core of the print drum 10 is constructed in the following manner: an electrically conducting layer 39 is applied over an insulation 29 on the carrier 23. The layer 39 serves as a line lead 43. A foil 38 is placed on the layer 39 which contains a matrix line with print elements 30 and the associated column leads 42. The individual sectors are mutually insulated from each other by insulation 28 that is emplaced between the sectors. On the front side of the print drum 10 a triggering unit 40 is positioned as per Figure 4 which is coupled with the column leads 42 and the line lead 43 constructed as foil conducting tracks.

As seen in Figure 7 the triggering unit 40 manifests a column switch 41 and a line switch 44. The line switch 44 connects each matrix line 33 with a voltage source 45 which is located in the area of the transfer print process point 18. By means of the column switch 41 the heating element 31 of a print

element 30 is connected with the voltage source 45 depending on the print information available. The heating element 31 manifests an electric resistance of 30 to 100 ohms and is acted on by a voltage between 5 and 40 volts from the voltage source 45.

The foil 38 is constructed with the help of methods known from printed circuit card techniques. The print elements 30 are constructed as pass-throughs with funnel-shaped openings, whereby the pass-throughs are closed by the heating elements 31. The heating element 31 extends to the bottom side of the foil 38 and can as a result come in direct contact with the layer 39. The conducting tracks 42 are embedded in the foil 38.

Because of the expected thermal stress on the foil 38 and the current stress of the voltage source 45 the directly adjacent print elements 30 along the matrix line are displaced and positioned on both sides of a symmetry line. Since the rotation speed of the print drum 10 is greater than the transport speed of the print carrier 14, a transfer of the ink 13 with exact positioning can be guaranteed on the print carrier by means of appropriate triggering of the print elements 30 that are located either on one or the other side of the symmetry line 46. The delayed triggering results in an equal current loading of the voltage source 45.



Another variant of the arrangement of the matrix line 33 on the print drum 10 is shown in Figures 10 and 11. Two matrix lines 33 run diagonally on the print drum 10 between the front sides of the print drum 10. The rotation speed of the print drum 10 is greater than print carrier speed and the individual print elements 30 of the matrix lines are accordingly so controlled, that the ink 13 can be transferred to the print carrier 14 with an exact position. As in the previous versions the print elements 30 are connected by means of column leads 42 to a triggering unit 40. As per Figure 12 a layer 47 containing the heating element 31 and the column leads 42 is applied to the carrier 23. In addition, a layer 48 of oligophobic material is applied which manifests pass-throughs 49 in the area of the heating elements 31.

According to Figure 13 the thermoelectric print unit of Figure 1 is expanded around an intermediate carrier 51. The printed picture is transferred to this intermediate carrier 51 with the assistance of a print drum 10 outfitted as described above. The print drum 10 thereby acts in conjunction with an inking station 11, a stripping cover strip 21, and a cleaning station 22. The printed picture transferred to the intermediate carrier 51 is transferred to a print carrier 14 at the transfer print process point 56.

The intermediate carrier 51 is designed as a circular cylindrical roller with an elastic cover surface. At the transfer print process point 56 the print carrier 14 is transported between the counter-printing roller 55 and the intermediate roller 51 which roll tangentially on each other. The printed picture is transferred to it by direct contact of the intermediate roller 51 with the print carrier 14. The elastic cover material of the intermediate roller 51 causes a high quality of transfer print process to be achieved even with rough surfaces on the print carrier 14 or uneven surface characteristics, like when printing labels. In addition, the use of an intermediate roller 51 causes protection of the print drum 10 from any dirting, that appears due to the passing transport of the print carrier 14 in the immediate vicinity of the print drum 10. By means of special spatial separation measures (not shown), like for example the inclusion of a print drum 10 in an almost completely enclosed housing, the spatial separation can be achieved.

A thermoelectric print unit which is suitable for multi- /5 color printing is shown in Figure 14. An intermediate carrier 50 transports a multi-color printed picture emplaced on a print carrier 50 to a transfer print process point 56, where the printed picture is transferred to the print carrier 14 by means

of interaction between the intermediate carrier 50 and a counter-printing roller 55. The intermediate carrier 50 is constructed as an intermediate carrier belt which is transported between two deflection rollers 53, 54. Four transfer print process rollers 10.1, 10.2, 10.3 and 10.4 are positioned along the intermediate carrier belt 50. The ink 13 is transferred to the intermediate carrier 50 with the help of these transfer print process rollers. Each transfer print process roller 10 is associated with an inking station 11.1, 11.2, 11.3 and 11.4. Each inking station 11 is filled with ink 13 of a different color. This ink is stripped from the surface of the print drum 10 with the help of a stripping cover strips 21.1, 21.2, 21.3 and 21.4. The transfer print process procedure between the print drum 10 and the intermediate carrier 50 is so triggered, that a complete color printed picture lies on the intermediate carrier and is transported from it to the transfer print process point 56, where it is transferred to the print carrier 14. After the transfer print process to the print carrier 14 on the intermediate carrier 50 any remaining ink residue is removed by a cleaning station 52 which is positioned in front of the print drum 10.1. Since the transfer print process occurs at the individual print drums 10 without contact to the intermediate carrier band 50, no color spreading must be feared. A

synchronization of the motors of the print drums 10 is possible without any problems using known mechanical or electronic means.

#### **Reference Designation List**

- 10 = Print drum
- 11 = Inking station
- 12 = Distribution roller
- 13 = Ink
- 14 = Print carrier
- 15 = Direction of turning
- 16 = Print carrier transport device
- 17 = Separation
- 18 = Transfer print process point
- 19 = Transfer print process roller
- 20 = Trough
- 21 = Stripping cover strip
- 22 = Cleaning station / cleaning roller
- 23 = Carrier
- 24 = First layer
- 25 = Second layer
- 26 = Protective layer
- 27 = Third layer
- 28 = Insulation

29 = Insulation  
30 = Print element  
31 = Heating element / heating device  
32 = Column  
33 = Line / matrix line  
34 = Line separation  
35 = Column separation  
36 = Funnel-shaped pass-through  
38 = Foil  
39 = Layer  
40 = Triggering unit  
41 = Column switch  
42 = Column lead  
43 = Line lead  
44 = Line switch  
45 = Voltage source  
46 = Symmetry line  
47 = Layer  
48 = Layer  
50 = Intermediate carrier / intermediate carrier band  
51 = Intermediate carrier / intermediate carrier roller  
52 = Cleaning station  
53 = Deflection roller

54 = Deflection roller

55 = Counter-printing roller

56 = Transfer print process point

#### **Patent Claims**

[Patent claims are provided in German, **ENGLISH**, and French]

#### **Claims**

1. A thermoelectric printing unit for transferring an ink onto a recording medium, with

- a printing drum,
  - more than one matrix row of printing elements which are arranged on the printing drum and which are each designed as a depression in the surface of the printing drum, a selectively activatable heating device being provided in the depression,
  - an inking station which is arranged on the circumference of the printing drum and by means of which ink can be introduced from the surface of the printing drum into the printing elements, and
  - a transfer printing point, at which the heating elements can be activated according to printing information, as a result of which the ink can be expelled out of the corresponding printing elements towards the recording medium.
2. The thermoelectric printing unit as claimed in claim 1, with an inking station which contains:
- a distributor roller, the surface of which rolls tangentially on the surface of the printing drum,
  - a trough which extends along the distributor roller and is filled with ink and into which the distributor roller partially dips.
3. The thermoelectric printing unit as claimed in claim 2, with a stripping batten which follows the rolling region in the direction of movement of the printing drum and which extends along the surface of the printing drum and strips excess ink from the surface.
4. The thermoelectric printing unit as claimed in one of the preceding claims, with a cleaning station which is arranged on the circumference of the printing drum and which can, if required, be brought into contact with the surface of the printing drum.
5. The thermoelectric printing unit as claimed in one of the preceding claims, with a hydrophobic and/or oleophobic protective layer forming the outer surface of the printing drum.
6. The thermoelectric printing unit as claimed in one of the preceding claims, with an arrangement of the printing elements as an endless matrix, said arrangement corresponding to the resolution of the printing image.
7. The thermoelectric printing unit as claimed in one of claims 1 to 5, with an arrangement of at least two matrix rows which extend axially on the printing drum and the heating elements of which can be activated alternately.
8. The thermoelectric printing unit as claimed in claim

- 7, in which the directly adjacent printing elements are arranged to be offset along the matrix row on both sides of a bisecting line.
9. The thermoelectric printing unit as claimed in one of claims 1 to 5, with matrix rows extending diagonally between the end faces of the printing drum.
10. The thermoelectric printing unit as claimed in one of the preceding claims, with a recording medium which is designed as an intermediate carrier and which rolls on a printing material in the region of a backing device, as a result of which the printing image can be transferred onto the printing material.
11. The thermoelectric printing unit as claimed in claim 10, with a plurality of printing drums assigned to the intermediate carrier.
12. The thermoelectric printing unit as claimed in one of the preceding claims, with an activation unit for the selectively activatable heating devices, which activation unit can be coupled to the printing drum.



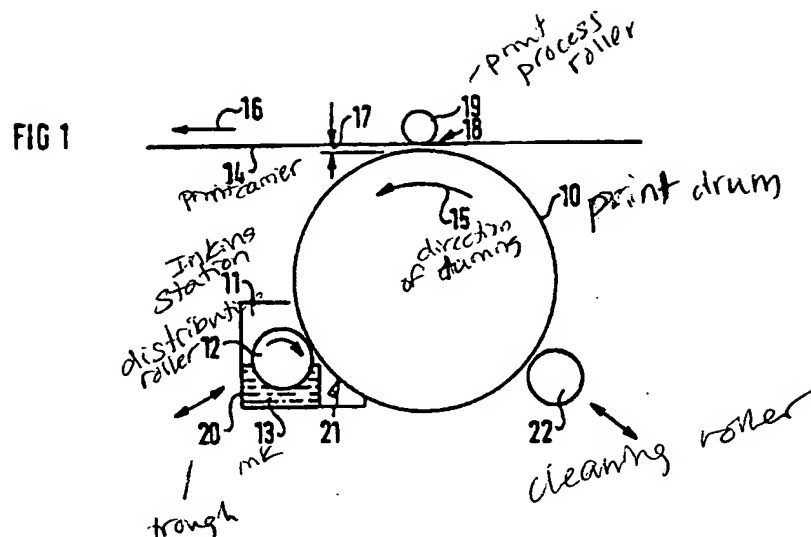


Figure 1

FIG 2

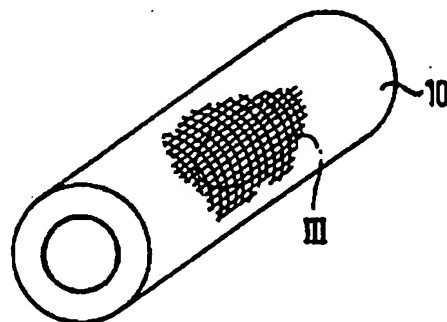


Figure 2

FIG 3

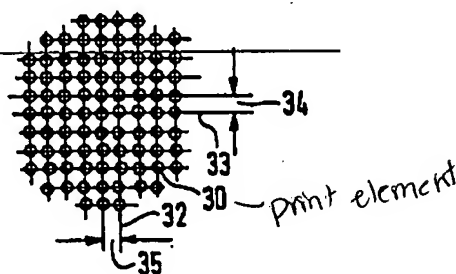


Figure 3

FIG 4

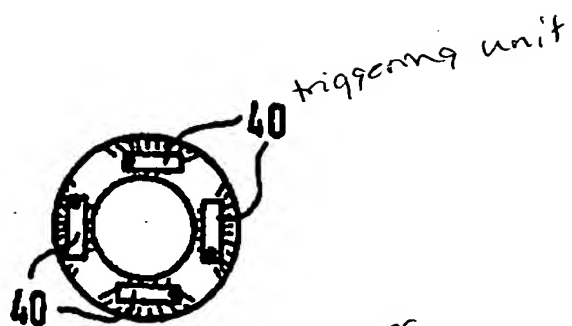


Figure 4

FIG 5

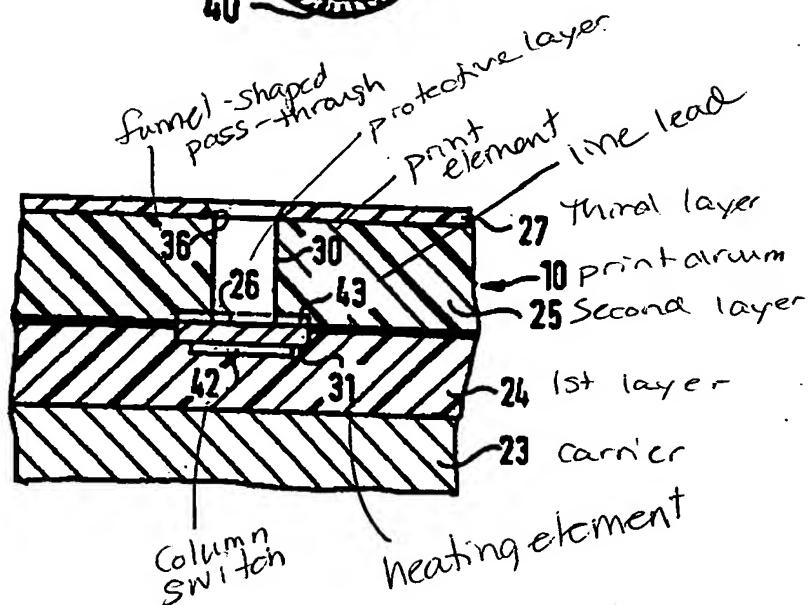


Figure 5

FIG 6

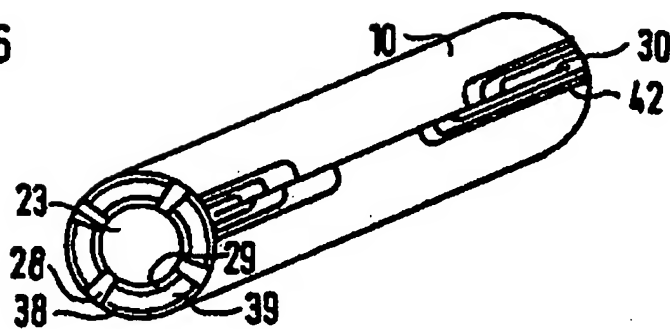


Figure 6

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FIG 7

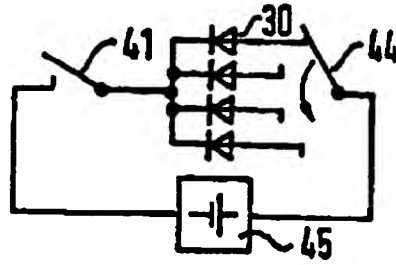


Figure 7

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FIG 8

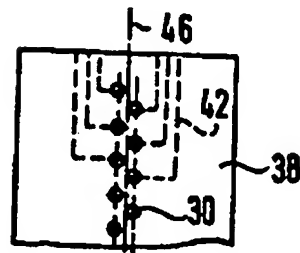


Figure 8

FIG 9



Figure 9

FIG 10

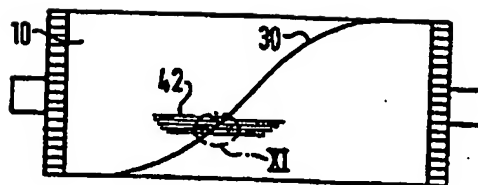


Figure 10

FIG 11

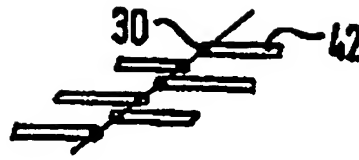


Figure 11

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FIG 12

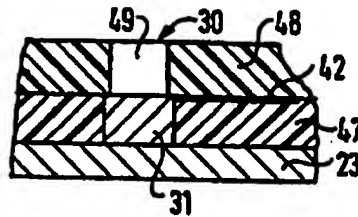


Figure 12

FIG 13

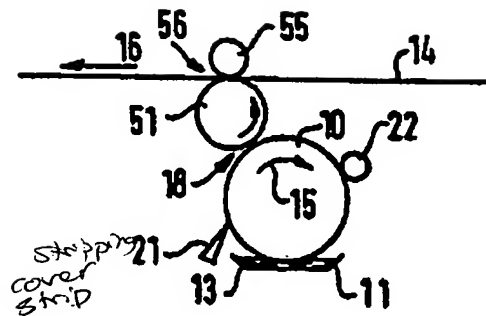


Figure 13

FIG 14

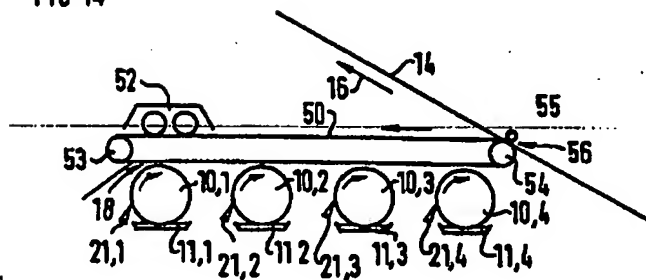


Figure 14